

AD-A082 742

AIR FORCE PACKAGING EVALUATION AGENCY WRIGHT-PATTERSON--ETC F/8 11/9  
EVALUATION OF POLYIMIDE FLEXIBLE FOAM, (U)

MAR 80 W P ROBBINS

UNCLASSIFIED

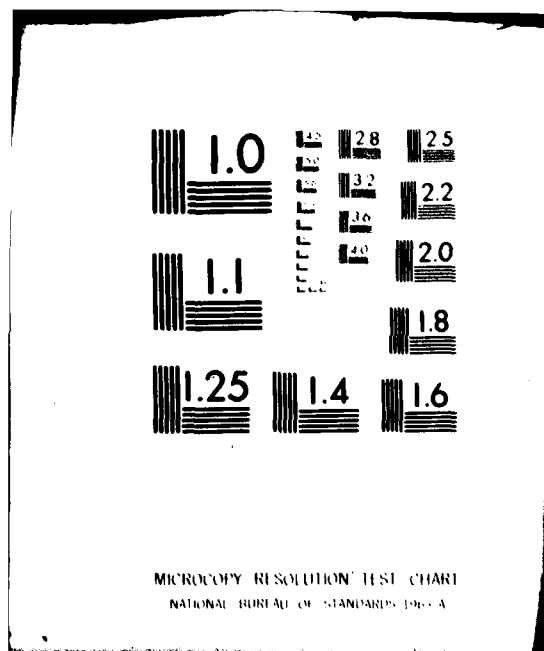
PTPT-80-6

NL

1 of 1  
AL  
AD-A082 742



END  
DATE  
FILMED  
5-80  
DTIC



LEVEL <sup>14</sup>

APPROVED FOR PUBLIC RELEASE  
DISTRIBUTION UNLIMITED

PTPT ~~SECRET~~ No. 80-6  
AFPEA Project No. 79-P7-105

(12) B.S.

10  
W. / PAUL ROBBINS  
Materials Engineer

AUTOVON 787-4519  
Commercial (513)257-4519

DTIC  
FLECTE  
APR 4 1980  
S D C

6  
EVALUATION OF POLYIMIDE FLEXIBLE FOAM

✓ HQ AFALD/PTP  
AIR FORCE PACKAGING EVALUATION AGENCY  
Wright-Patterson AFB OH 45433

11  
MAR 28 1980

(12) 10

ADA 082742

DDC FILE COPY

80 4 3 032

✓ B

# NOTICE

When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States Government thereby incurs no responsibility whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto. This report is not to be used in whole or in part for advertising or sales purposes.

## ABSTRACT

A 0.5 pcf polyimide flexible foam developed by Solar Turbines International, Division of International Harvester Corp., was evaluated for cushioning and flammability characteristics. The results showed that the dynamic cushioning characteristics were equivalent to 0.5 polyurethane foam at 72°F, superior at -40°F and the foam has improved reuseability. When exposed to a flame of a bunsen burner the polyimide foam was considered non-burning, with little smoke emission or odor.

*Regress*

Accession For	
WFO	<input checked="" type="checkbox"/>
DDO TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Availand/or special
A	

PREPARED BY: *Paul Robbins*  
PAUL ROBBINS, Materials Engineer  
Materials Engineering Division  
AF Packaging Evaluation Agency

PUBLICATION DATE:

20 MAR 1980

REVIEWED BY: *Matthew A. Venetos*  
MATTHEW A. VENETOS  
Chief, Materials Engineering Division  
AF Packaging Evaluation Agency

APPROVED BY: *Jack E. Thompson*  
JACK E. THOMPSON  
Director, Air Force Packaging  
Evaluation Agency

## INTRODUCTION

In a joint effort with the Navy Logistics Engineering Group, an investigation of non-flammable cushioning materials has been conducted by this agency during the past several years. The flame retardancy test, ASTM D-1692, of MIL-P-26514, Polyurethane Foam, Rigid or Flexible, for Packaging has not been considered entirely satisfactory from the standpoint of realism in actual field situations. Recently, Solar Turbines International, Division of International Harvester Corp., San Diego, CA, submitted samples of newly developed polyimide foams developed under contract with NASA-Johnson Space Center, Houston, TX. The purpose of the contract was to develop thermally stable, fire-resistant, low smoke emitting, low toxicity, cost effective materials for aircraft and spacecraft intended for long duration flights. The polyimide flexible foams were the result of one phase of this development program. At the present time, Solar Turbine International furnishes the material as pre-foamed cushioning material. Investigations are being conducted to explore the possibilities of using foam-in-place packaging techniques.

This report presents the results of dynamic cushioning, creep, compression set tests, and a selected test for evaluating the flammability properties of the foam.

## TEST INSTRUMENTATION AND EQUIPMENT

The following instrumentation and equipment were employed during this evaluation:

1. Oscilloscope, Tektronic, 4 channel storage, Model 565B.
2. Accelerometer, Statham, Model A5-100-350.
3. Amplifier, Sensotec, Model RM-6.
4. Energy Computer, GHI Systems, Model EC700.
5. Hardigg Cushion Tester, Hardigg Industries, Inc., Model 3.

## DYNAMIC CUSHIONING TEST (72°F, 50% R.H.)

The dynamic cushioning test was conducted in accordance with ASTM Test Method D-1596, Dynamic Properties of Package Cushioning Materials. The sample sizes were 8 x 8 x 3 inches. The drop tests were conducted at a height of 24 inches. Five drops were made on each of three test specimen at each of the following static stress values: 0.066, 0.08, 0.1, 0.15, 0.2, 0.3, 0.4, 0.5, and 0.6 psi.

Test Results: The test results are presented in the form of peak acceleration - static stress curves in Graph 1. The dynamic cushioning curves from MIL-P-26514, Type II, Class 2 (Flexible), Grade C for 0.5 pcf polyurethane foam is displayed for comparative purposes. The polyimide foam is within the requirements of these curves. In addition, the polyimide foam did not fracture or split throughout the entire 0.066 psi to 0.6 psi range. These results indicate that the foam should have excellent reusability. The 0.5 pcf polyurethane foams currently used begins to fracture at approximately 0.15 psi. Two of the polyimide specimens did display evidence of slight permanent deformation after completion of the 0.5 psi load test.

#### DYNAMIC CUSHIONING TEST (-40°F)

Due to a lack of sufficient polyimide foam, it was necessary to use the same specimens that were used in generating the data for Graph 1. As a consequence, due to compression set, the average thickness for these specimens was 2.70 inches instead of the normal 3 inches. Five drops were made on each test specimen at each of the following static stress values: 0.1, 0.2, and 0.4 psi. The five drops at each individual static stress value were completed in rapid succession with minimal rest time between drops. The specimens were rested for a minimum of two hours before being tested at the next higher static stress value. Tests were first conducted at a temperature of 72°F and a relative humidity of 50%. Samples were allowed to recover for six hours before being placed in the cold chamber at -40°F and conditioned for 16 hours. Specimens were then brought out of the cold chamber in an insulated box, one at a time, for a series of free fall drops made from a height of 24 inches. Five drops were made on each test specimen at 0.1, 0.3, and 0.4 psi. The five drops at each individual static stress were completed in rapid succession with minimal rest time between drops. Samples were returned to the cold chamber for conditioning at -40°F for a minimum of two hours before being tested at the next higher static stress value.

Test results: The test results are presented in Graph 2. The dynamic cushioning curves for the +72°F data is presented for comparative purposes. The test specimens displayed no fracturing or splitting throughout the 0.1 to 0.4 psi range. The polyimide foam showed the approximately the same dynamic cushioning characteristics at -40°F as at +72°F.

#### FLAMMABILITY PROPERTIES OF POLYIMIDE FOAM

Specimens of the polyimide, 3 x 8 x 8 inches, foam were exposed to a 4 to 5-inch high flame of a bunsen burner for 60 seconds. The specimens were then removed from the flame. There was no burning, smoking, or odor from the specimens. There was approximately 15 to 20% erosion of the specimen where it was in contact with the flame. The foamed material would be considered non-burning from the results of this test.

#### DENSITY

Density of a sample of the polyimide foam measuring 8 x 8 x 3 inches was determined IAW Federal Test Method Standard No. 101B, Method 4008 to be 0.538 pound per cubic foot.

#### CREEP CHARACTERISTICS

The creep of three samples measuring 6 x 6 x 3 inches was evaluated IAW Federal Test Method Standard No. 101B, Method 2013. The average creep of the samples tested was 10.5% after 96 hours. This value was within the acceptable requirement (15% max.) of MIL-P-26514 for polyurethane foams, flexible, Type II, Class 2.

#### COMPRESSION SET

Compression set of three samples measuring 6 x 6 x 3 inches was evaluated IAW MIL-P-26514E, paragraph 4.5.3.7. The average compression set of the samples tested was 5%. This value was well within the requirement of 15% or less compression set for polyurethane foam, flexible, Type II, Class 2 as established by MIL-P-26514E, paragraph 3.7.2.

7

THE UNIVERSITY OF CHICAGO

2004-04-22

2 CYCLES x 10 DIV 50VS 205 400P

535 S.W.2d 817

**GRAPH # 1**

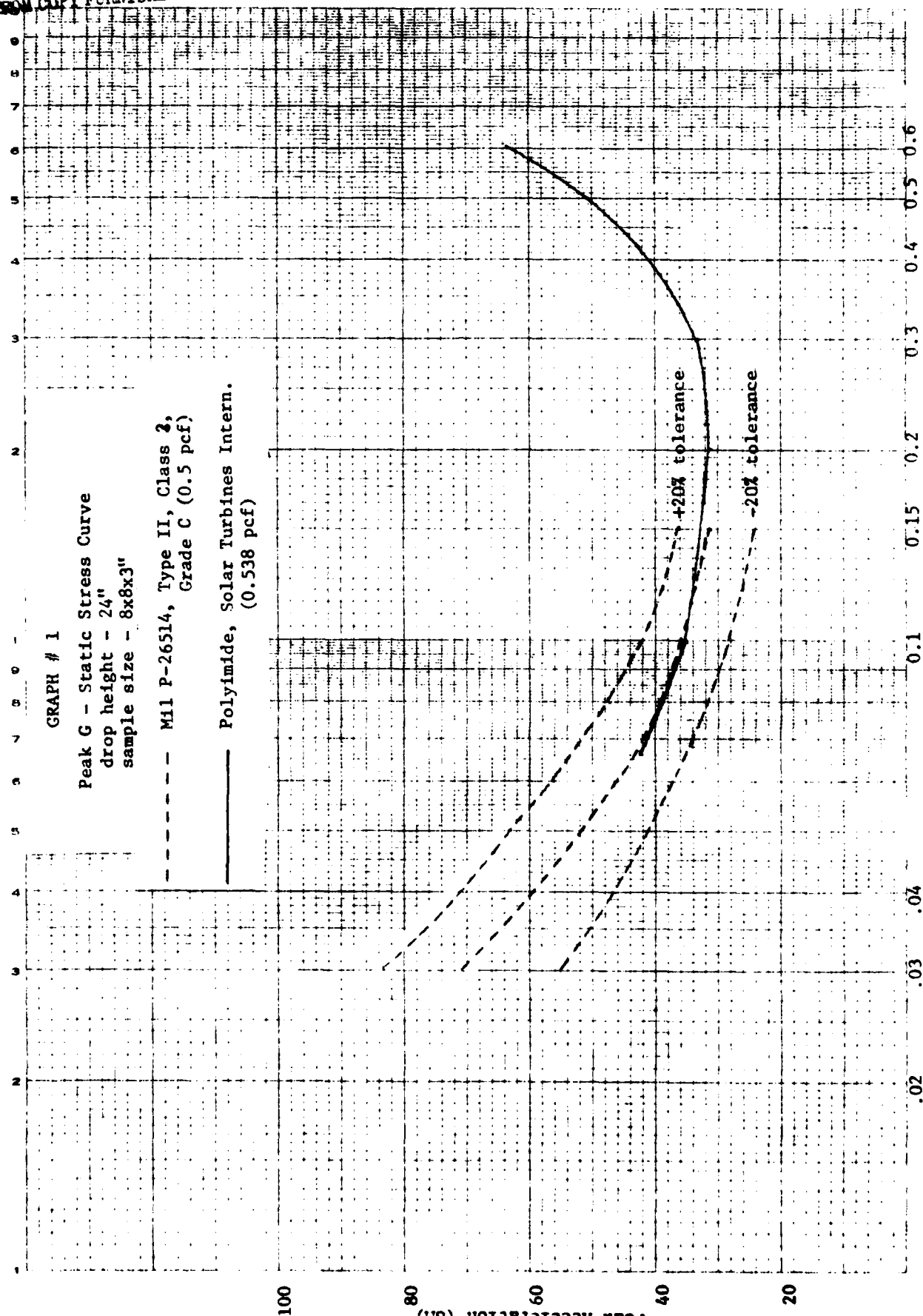
### Peak G - Static Stress Curve

drop height - 24"

sample size - 8x8x3"

----- M11 P-26514, Type II, Class 2,  
Grade C (0.5 pcf)

\_\_\_\_ Polyimide, Solar Turbines Intern.  
(0.538 pcf)

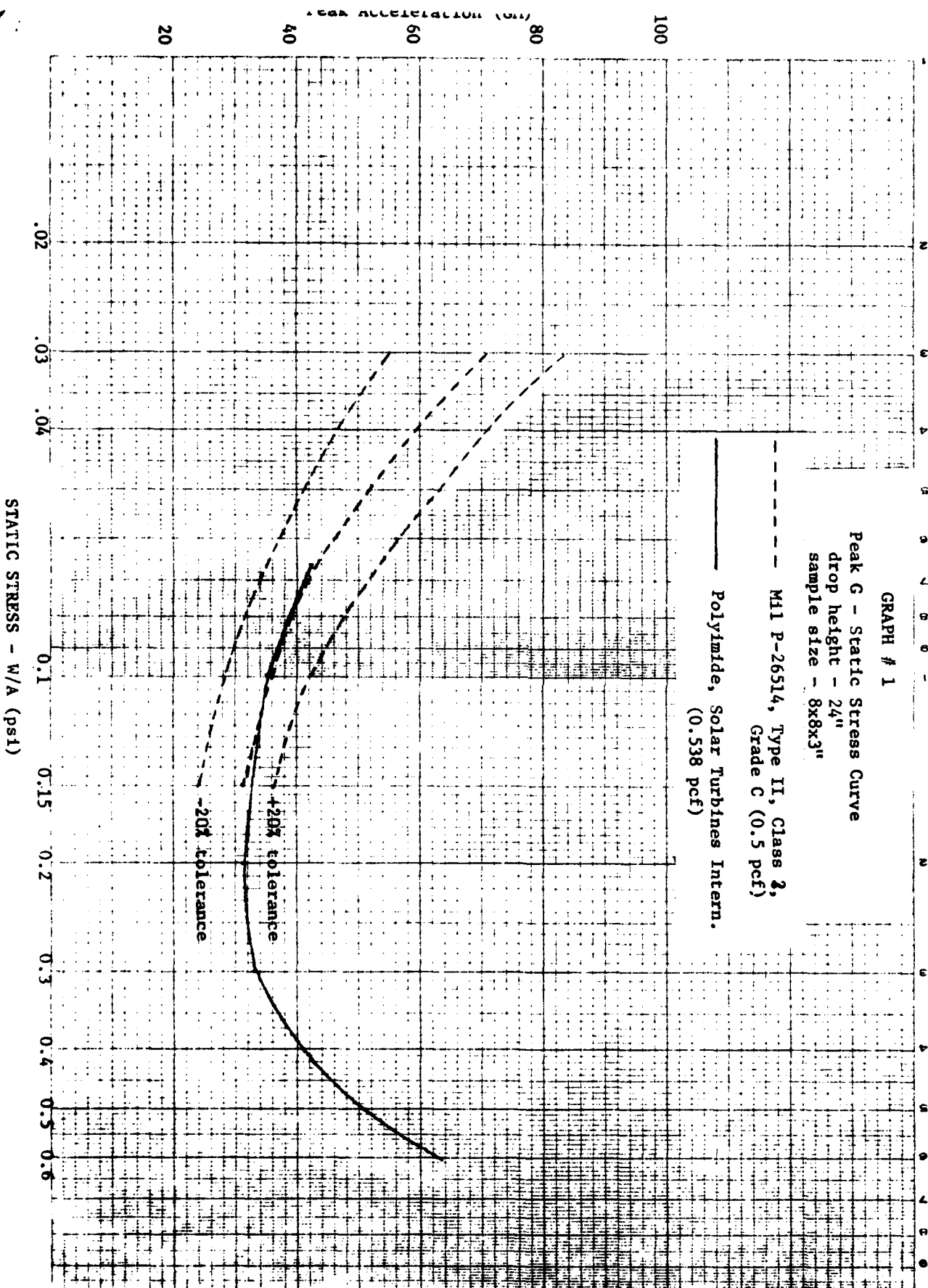


STATIC STRESS - W/A (psi)



NO. 101-201 DITTESEN, J. L. CASEY  
 SEM. 101-201-101  
 2 CYCLES X 10 DIVS. DWS 355 PCF  
 GRAPH # 1

LINE INFORMATION CO.  
 101-201-101



THIS PAGE IS BEST QUALITY PRINTABLE  
 FROM COPY FURNISHED TO DDC

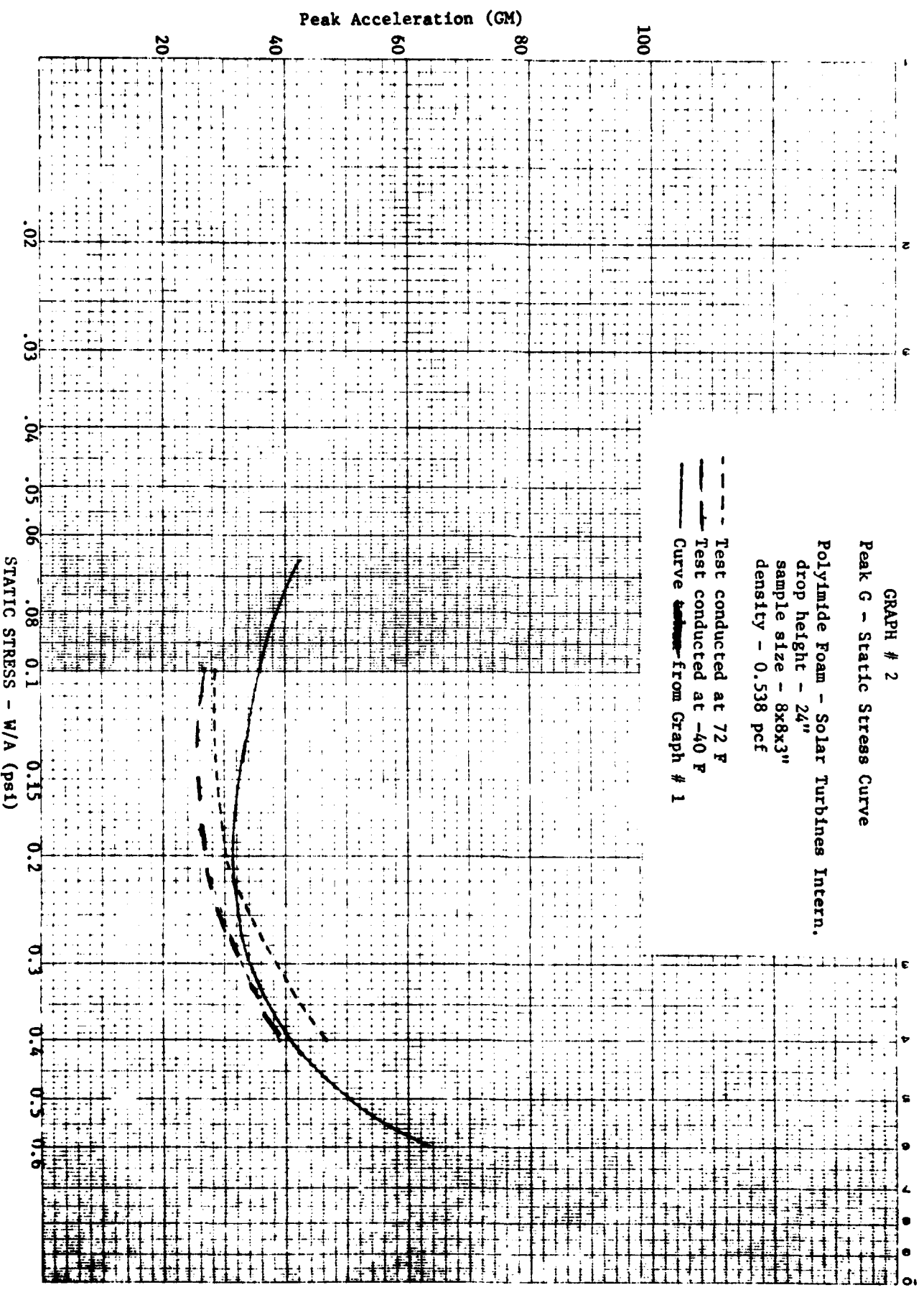
100 1400 210 DIETZGEN GRAPH PAPER  
 100 1400 210 DIETZGEN GRAPH PAPER  
 100 1400 210 DIETZGEN GRAPH PAPER

GRAPH # 2

Peak G - Static Stress Curve

Polyimide Foam - Solar Turbines Intern.  
 drop height - 24"  
 sample size - 8x8x3"  
 density - 0.538 pcf

- Test conducted at 72 F
- - - Test conducted at -40 F
- Curve ~~estimated~~ from Graph # 1



# DISTRIBUTION LIST

	<u>COPIES</u>		<u>COPIES</u>
HQ USAF/LETT Wash DC 20330	1	Naval Ship R&D Ctr Code 2841 Annapolis, MD 21402	1
Tobyhanna Army Depot Attn: AMSTO-T Tobyhanna PA 18466	1	HQ US Army Aviation Systems Command DRSAV-EKS P.O. Box 209 St. Louis, MO 63166	2
Tobyhanna Army Depot Attn: SDSTO-TP-P Tobyhanna PA 18466	2	Naval Air Engineering Center (ESSD) Code 93 Lakehurst, NJ 08733	2
AFSC/SUP Andrews AFB DC 20334	1	HQ AFLC/LOZPP	1
OO-ALC/DSTC Hill AFB UT 84406	2	ASD/AWL	1
OC-ALC/DSP Tinker AFB OK 73145	2	DLSIE USA Logistics Mgmt Cen Ft. Lee VA 23801	2
SA-ALC/DSP Kelly AFB TX 78241	2	USA Natick Labs Attn: DRDNA-EPS Natick MA 01760	1
SM-ALC/DSP McClellan AFB CA 95652	2	DESC-T 1507 Wilmington Pike Dayton, OH 45444	1
WR-ALC/DSP Robins AFB GA 31098	2	DTIC/TSR Cameron Sta Alexandria VA 22314	12
JMPTC Aberdeen Proving Grounds MD 21005	2	NAVSUPSYSCMD Attn: SUP-0321A Wash DC 20376	5
AFALD/PT	1	ADTC Attn: SD3P Eglin AFB FL 32542	1
AFALD/PTP	10	USA, Armament Research & Devel Comd Attn: DRDAR-TST-S Dover NJ C7801	1
AFALD/PTP Library	20	Thomas C. Corbe Naval Electronics Systems Command Code 460T Wash DC 20362	1
Naval Supply Systems Code 0321B Wash DC 02376	1	J.A. Enslow Naval Electronics Systems Command (Code 460T) Wash DC 20362	1
Naval Log Engrg Grp Cheatham Annex Williamsburg, VA 24991	1		

# DISTRIBUTION LIST (Cont'd)

	<u>COPIES</u>		<u>COPIES</u>
L.W. Bell Aviation Supply Office (TEP-A) 700 Robbins Avenue Philadelphia, PA 19111	1	Mr. Joseph Brugh Director, Naval Logistics Engineering Group Cheatham Annex Williamsburg, VA 23185	1
Ships Parts Control Center J.C. Thomas Navy Ships Parts Control Center Code 561 Mechanicsburg, PA 17055	1	Joseph Diliberti/DTNSRDC Naval Ship Research & Dev. Center Code 2833 Annapolis MD 21402	1
M. Bebel Naval Air Engineering Center ESSD, Code 93 Lakehurst, NJ 08733	1	Fred Pearlstein Naval Aviation Supply Office Code TEP2-A Philadelphia, PA 19111	1
John Neubauer Naval Supply Systems Command (SUP0321A) Wash DC 20376	1	Phil Smith Naval Weapons Support Center Code 505 Crane, Indiana 46522	1
Elizabeth Foster Naval Supply Systems Command (SUP 0321C) Wash DC 20376	1		
E.A. Panigot Naval Air Systems Command (AIR 4121B1) Wash DC 20361	1		
Thomas Fleming Naval Facilities Engineering Command (FAC 0454), Rm 9S27, Hoffman Bldg #2 Alexandria, VA 22332	1		
G.S. Mustin Naval Sea Systems Command (SEA62T2) Wash DC 20362	1		
A.V. Anceravage Naval Sea Systems Command (SEA 05D23) Wash DC 20362	1		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER PTPT Report No. 80-6	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Evaluation of Polyimide Flexible Foam		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) W. Paul Robbins		6. PERFORMING ORG. REPORT NUMBER AFPEA Project No. 79-P7-105
9. PERFORMING ORGANIZATION NAME AND ADDRESS AFALD/PTPT Wright-Patterson AFB OH 45433		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS AFALD/PTP Wright-Patterson AFB OH 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE March 1980
		13. NUMBER OF PAGES 8
		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Foam, cellular      Polyurethane foam      Flammability Cushioning foam      0.5 pcf foam      Non-burning Flexible foam      Dynamic Cushioning Polyimide foam      Compression set		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A 0.5 pcf polyimide flexible foam developed by Solar Turbines International, Division of International Harvester Corp., was evaluated for cushioning and flammability characteristics. The results showed that the dynamic cushioning characteristics were equivalent to 0.5 polyurethane foam at 72°F, superior at -40°F and the foam has improved reuseability. When exposed to a flame of a bunsen burner the polyimide foam was considered non-burning, with little smoke emission or odor.		